



DoD Executive Agent

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Assistant Secretary
of the Army
(Installations and
Environment)

Conversion of Wood Debris into Alternative Construction Materials

**Presented by:
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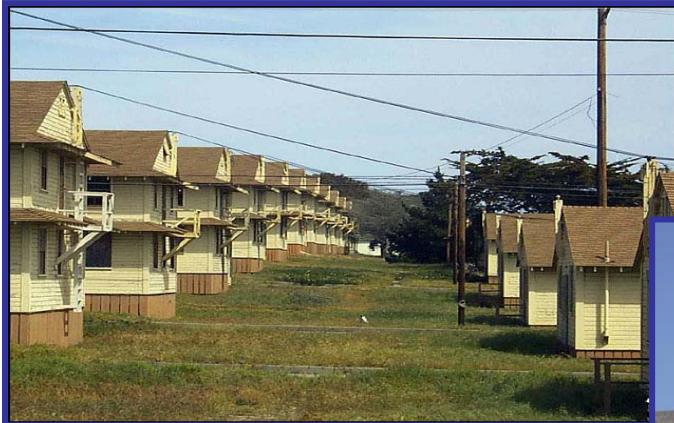
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Presentation Overview



- Background
- Technology Concept
- Process Description
- Preliminary Feasibility Study
- Additional Resources

U.S. Army Construction and Demolition (C&D) Waste



Estimated 27 million ft² of surplus wood-framed buildings; \$350 million to demolish



Around 20 million tons of building related debris projected over 15 years

Goal to divert minimum 50% by weight of debris from landfills



Army Wood Debris- Potential Quantities



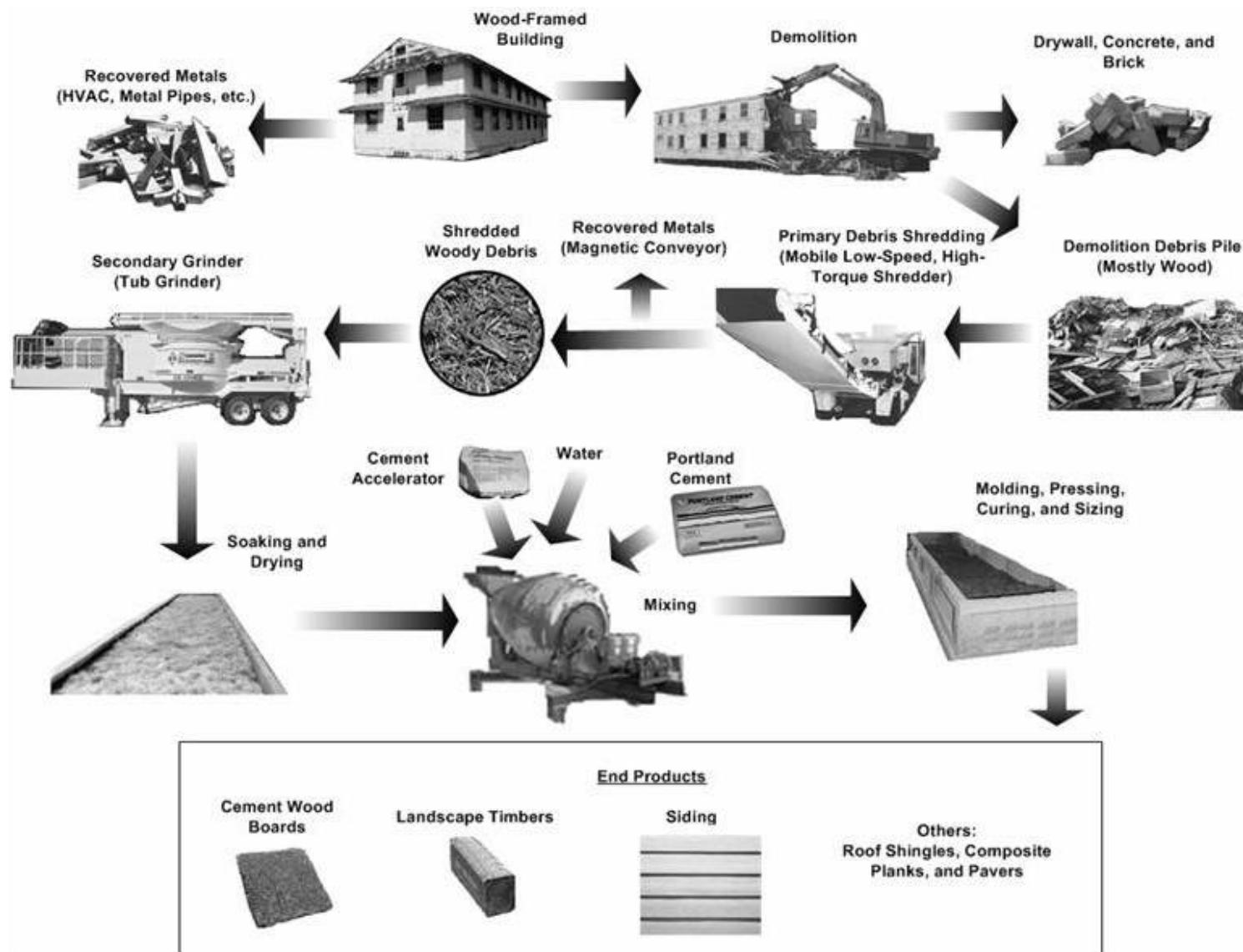
- WWII-era 2-story wood barrack:
 - 30,000 board feet (50,000 linear feet) of total wood materials
- Estimated 250 million board feet of wood available in Army WW-II building inventory slated for removal
- *Army-Wide Survey Numbers*

Data Sources:

1. Draft ESCTP Demonstration Plan: Reclamation of Wood Materials Coated with LBP, ERDC-CERL, 2004.
2. Alternatives To Demotion: Opportunities to Reduce Solid Waste through Deconstruction, Reuse, & Recycling of Building Materials, ERDC-CERL Presentation, 2002.
3. Alternatives to Demolition: Opportunities to Deconstruct, Reuse, & Recycle Materials from Army Building, DoD Deconstruction Training SWANA ERDC-CERL, 2003.
4. Falk, R., Janowiak J., Beakler, B., Lampo, R., and Napier, T., "Remilling of Salvaged Wood Siding Coated with Lead-Based Paint, Part II. Wood Product Yield," Forests Products Journal, Vol 55, No. 7/8, July/August 2005, pp. 81-86

CEHNC Concept:

- Rapid removal of Army wood buildings with a means to divert large volumes of C&D debris materials
- NDCEE was tasked to:
 - Define technology concept
 - Conduct preliminary feasibility study



Typical Material Composition of 2-Story WWII-Era Wood-Framed Army Barrack

Materials	Total Quantities		Composition By Weight
	(tons) ¹	(lbs)	
Asphalt Shingles	3	6,000	3%
Brick	9	18,000	8%
Concrete	22	44,000	20%
Drywall	20	40,000	18%
Metals	2	4,000	2%
Miscellaneous ²	1	2,000	1%
Plastics	1	2,000	1%
Wood	52	103,000	47%
Total	110	219,000	100%



Feedstock: Woody Demolition Debris

Process Input Composition Following Demolition and Material Segregation

Materials	Material Input Quantities Per Demolished Barrack (lbs)	Weight Composition
Asphalt	6,000	4%
Brick	*	--
Concrete	*	--
Drywall	40,000	26%
Metal	800	0.5%
Miscellaneous	2,000	1%
Plastic	2,000	1%
Wood	103,000	67%
Total	153,800	100%

* Normally recycled for reuse.



Demolition



Mobile Low Speed High Torque Grinder

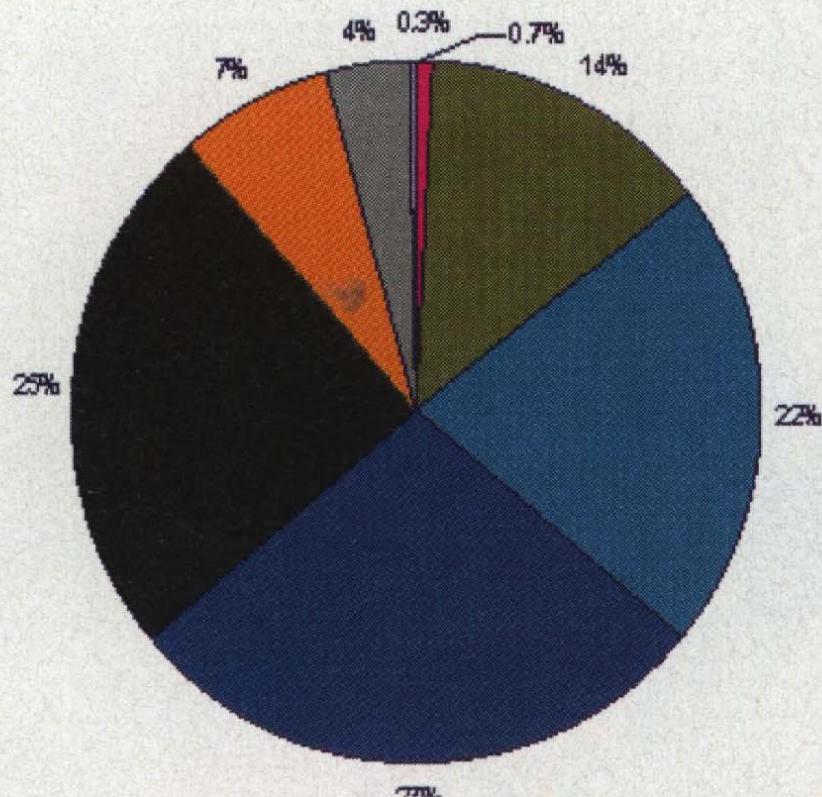


Tub Grinder

Feedstock: Wood Debris from Disaster Areas



Figure 1. Markets for Hurricane-Generated Mulch (2004)*



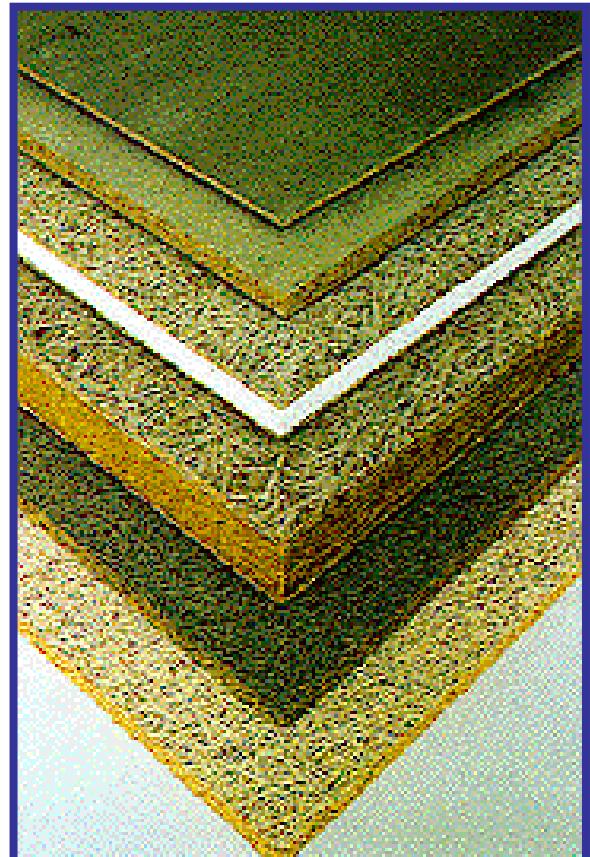
Source:
Burgeil, J., McLendon, C., "Green Sweep: Florida Communities Reel From
Hurricanes, Learn Valuable Lessons," MSW Management,
Sep/Oct 2005.

■ Burn ■ Domestic Power ■ Export Power ■ Landfill Disposal ■ Daily Cover ■ Composting ■ Landscaping/Ground Cover ■ Other

Alternative Market

■ End Product: Cement-Bonded Wood Composite

- Alternative concrete products made by combining Portland cement with wood particles in place of conventional aggregate
- Properties
 - Lighter than conventional concrete
 - High insulating value
 - Resistant to frost, rot, water, fire, and termites
 - Good sound absorption
- Produced using rudimentary tools and unskilled labor



Wood Wool Cement Boards

■ End Product: Cement-Bonded Wood (Cont'd)

- Wide range of external and internal uses, including as substitutes to:
 - Plywood
 - Drywall
 - Non-structural applications such as siding and sheathing
- Easily molded into a variety of common construction forms
 - Planks, blocks, lumber
 - More complex shapes may require the use of an extruder



Houses Made With Cement Wood

Properties of Cement-Bonded Wood Composite Boards

Density:	450 kg/m ³ (medium density) to 750 kg/m ³ (high density)
Acoustic Insulation:	Sound reduction of 10 mm thick board = 31 dB
	Sound reduction of 20 mm thick board= 33 dB
Fire Resistance:	5 cm thick board = 1 hour of resistance
	10 cm thick board = 2 hours of resistance
Thermal Resistance:	Thermal conductivity (k value)=0.35 W/m.K;Linear thermal expansion=0.01 W/m.K
Water Resistance:	Thickness swelling:
	<1.0% after 2 hours of soaking
	<1.5% after 24 hours of soaking
	<2.0% after >24 hours of soaking
Bending Strength:	10–15 N per cubic mm
Load Capacity:	Design Load = 50 psf, Ultimate Load = 200 psf
Compressive Strength:	15 N per cubic mm
Modulus of Elasticity:	4500 Nm

Source: <http://sres.anu.edu.au/associated/fpt/cfb/properties.html#org>, December 2005.

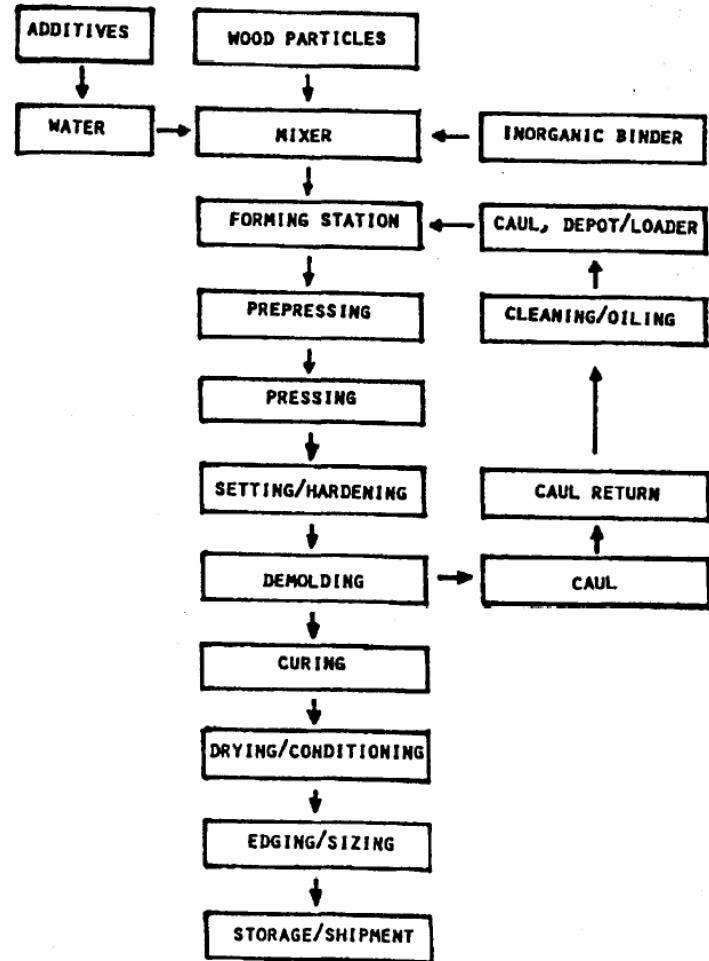
Manufacturing of Cement-Bonded Wood Composites



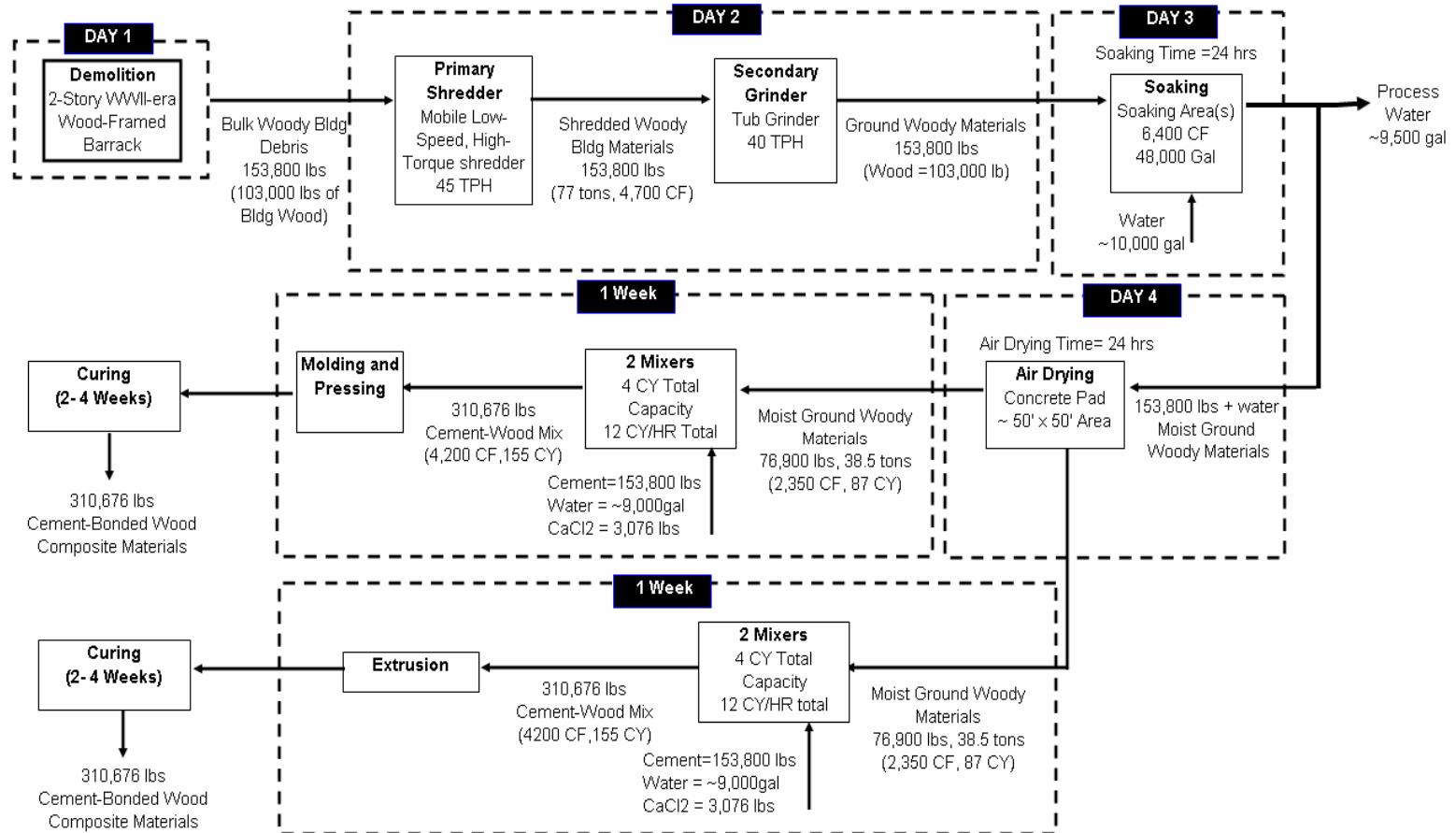
Molding



Stacking and Storage



Process Time for Cement-Bonded Wood Manufacturing



Commercially Available Cement Wood Products



On-Site Applications



Storage Sheds and Emergency Shelters



<http://www.eltomation.nl/page4.html>

Housing

Preliminary Economic Analysis

	Cost	Unit	Description
Initial Investment	\$2 million	Lump Sum	Equipment Costs
Processing Cost	\$66,000	Per Barrack	<p>Demolition, Utilities, Labor, Materials, and Equipment Operation Costs</p> <ul style="list-style-type: none">• Demolition cost of \$4 /sq ft (\$35/ton landfill fee)• Processing cost rate of \$12.70/sq ft
Cost Saving	\$70,000	Per Barrack	<p>End product value & landfilling cost avoidance</p> <p>Assumes all wood cement board produced (~4000 per barrack) replaces base use of plywood (~\$15 each)</p>
Cost Benefit	\$4,000	Per Barrack	

Caveats

- **Wood feedstock commingled with non-wood (C&D) materials**
 - Productivity
 - Quality
 - Properties
- **Hazardous materials – lead-based paint, asbestos, etc.**
- **Process (soaking) water contaminants**
- **Regulatory requirements and permits**

Further Development

- Proof of Concept Testing**
- Material Testing**
- Process Refinement**
- Regulatory Permitting Survey**
- End Product Market Survey**
- Additional Cost Analysis**

Resources on Cement-Bonded Wood Composites

■ Articles and Studies

- “Cement and Wood-Wool Combine to Improve Philippine Housing,” [http://www.aciar.gov.au/web.nsf/att/ACIA-5KE7UT/\\$file/Cement_wood-wooPart14.pdf](http://www.aciar.gov.au/web.nsf/att/ACIA-5KE7UT/$file/Cement_wood-wooPart14.pdf)
- “Wastes Into Wood: Composites Are a Promising,”
<http://www.ehponline.org/docs/1994/102-2/innovations.html>
- “Durability and Strength of Cement Bonded Wood Particle Composites Made from Construction Waste,”
<http://www.fpl.fs.fed.us/documents/pdf1999/wolfe99a.pdf>
- “Production, Properties, Applications Of Various Wood Cement Products,”
<http://www.panelworldmag.com/vserver/hb/display.cfm?MagazineKey=6&IssueKey=453&SectionKey=389&ArticleKey=620>

Resources on Cement-Bonded Wood Composites

■ Organizations

- Australian Centre for International Agriculture Research and Australian National University: <http://www.aciar.gov.au/>
- Philippine Wood Cement Board Industry Website:
http://sres.anu.edu.au/associated/fpt/nwfp/woodwool/woodwool_phil.html
- USDA Forests Products Laboratories:
<http://www.fpl.fs.fed.us>

Questions & Comments



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